The Hogfish in Florida:
Assessment Review and Advisory Report

Report prepared for the
South Atlantic Fishery Management Council
Gulf of Mexico Fishery Management Council
National Marine Fisheries Service

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Southeast Data and Assessment Review

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PREFACE

Summary of the Commission Peer Review Process

The South Atlantic Fishery Management Council, the Gulf of Mexico Fishery Management Council, and the Caribbean Fishery Management Council, in conjunction with the National Marine Fisheries Service, have adopted the Southeast Data, Assessment and Review (SEDAR) process, a multi-step method for determining the status of fish stocks. SEDAR is structured around three workshops: 1) Data Workshop, 2) Stock Assessment Workshop and 3) Review Workshop. Participants in Data Workshops review input data, including catch statistics, fishery sampling and population monitoring data, and species life history. Participants in Assessment Workshops develop stock assessment models, estimate values for population parameters and stock status benchmarks, and project future population conditions. At Review Workshops an independent peer review panel provides a technical review of the data and of the assessment methods. The relevant Council Committees, such as the Science and Statistics Committees, must then certify the final assessment report before it can become eligible for use in developing management actions. The goal of SEDAR is to provide an open and transparent process for developing and reviewing scientific information that is critical to management of species in the Southeastern United States, including the South Atlantic, Gulf of Mexico, and Caribbean. The SEDAR process includes data collectors, biologists, fishermen, environmental representatives, database managers, stock assessment scientists and Council members and staff.

The State of Florida requested that the Fishery Management Councils and the National Marine Fisheries Service coordinate a review of an assessment[1] of the Hogfish (*Lachnolaimus maximus*) that had been prepared under contract to the State of Florida Marine Research Institute. In the case of this assessment, neither a data workshop nor an assessment workshop was held. Instead, the assessment document was presented to an Assessment Review Panel, normally the third and last stage of the SEDAR process, at a meeting in Tampa, Fla on 27–30 January 2004. The present document reports the results of that meeting. It does not present the assessment itself, but the Review Panel's views on the validity and limitations of both the assessment and the data upon which it was based. An Advisory Report, prepared

[1] Ault, J.S., S.G. Smith, G.A. Diaz and E. Franklin. 2003. Florida Hogfish Fishery Stock Assessment. Rep. prep. by Rosenstiel School of Marine and Atmospheric Science, University of Miami, for Florida Marine Research Institute, Florida Fish & Wildlife Conservation Commission, St. Petersburg, Fla. 89 pp.

by the Review Panel, and based on the conclusions it could draw from the assessment as to the current state of the stock and forecasts for its future, is appended.

Purpose of the Terms of Reference and Advisory Report

The 'Terms of Reference Report' provides a brief review of the stock assessment and the underlying data, with the SEDAR Assessment Review Panel's conclusions about the adequacy and appropriateness of both. The report does not repeat the detailed results of the assessment. An 'Advisory Report' on stock status and possible and appropriate management for the stock in accordance with SFA prescription is appended; however, as the Panel is specifically enjoined not to conduct an alternative assessment, the Advice that can be formulated is bounded by the adequacy of the assessment(s) that is (are) reviewed.

Acknowledgments

Thanks are due to the members of the SEDAR Assessment Review Panel who participated in the review—Ralph Allen (GMFMC Advisory Panel; Independent), Luiz Barbieri (GMFMC Scientific and Statistical Committee; Florida Fish and Wildlife Conservation Commission), Jon Brodziak (Reviewer; Northeast Fisheries Science Center, NMFS), Marianne Cufone (Reviewer; The Ocean Conservancy), Don DeMaria (SAFMC Advisory Panel; Independent), Michael Kingsley (Chairman; Center for Independent Experts), Debra Murie (GMFMC Finfish Assessment Panel; University of Florida), Michael Murphy (GMFMC Finfish Assessment Panel; Florida Fish and Wildlife Conservation Commission), Julie A. Neer (Reviewer; Southeast Fisheries Science Center, NMFS), Jay Rooker (GMFMC Finfish Assessment Panel; Texas A&M University), Richard Taylor (GMFMC Reviewer; Independent), Eddie Toomer (GMFMC Advisory Panel; Independent) and John Wheeler (Reviewer; Center for Independent Experts). We thank the presenters and other scientific staff for their work beforehand and for their clear and patient presentations at the meeting, and the members of the public, the fishermen, divers, and others, for their cooperative and constructive input to the review meeting. We thank the staff of the Fishery Management Councils, the National Marine Fisheries Service and other organisations for their contributions to the running of the meeting and for their input to the Review Panel's deliberations.

BACKGROUND ON THE HOGFISH.

The Hogfish, *Lachnolaimus maximus,* is a protogynous hermaphroditic reef fish. It is a bottom feeder, eating crabs, clams and other benthos, and is esteemed as a food fish. It is not vulnerable to angling, seldom taking a hook, but is a popular target for spearfishing. A size limit of 12" was introduced in 1994, but there is nonetheless some concern that the species may be growth- or recruitment-overfished in Florida waters.

TERMS OF REFERENCE FOR THE REVIEW OF THE FLORIDA HOGFISH ASSESSMENT.

Evaluate the adequacy and appropriateness of fishery-dependent and fishery-independent data used in the assessment (i.e., are the input data scientifically sound and up to date?).

Fishery data comprised Marine Recreational Fisheries Statistics Survey (MRFSS) data for 1982–2001, and FMRI trip ticket commercial fishery data for 1985–2001. The MRFSS creel-survey data were supplemented by creel surveys on head-boats in the Keys during 1978–1999 and at boat ramps in Biscayne National Park during 1976–1998. Trip ticket data covered commercial trips selling to licensed dealers.

The MRFSS data set was restricted to 'valid trips'. Of sampled recreational trips, valid trips comprised i) trips that caught hogfish; and ii) 'reef fish trips'[2] angling or spear-fishing from counties in which hogfish were caught; although 'reef fish trips' angling from shore were only deemed valid if from counties where hogfish were caught in this way. The catch, and the effort, of valid sampled trips were extrapolated on the basis of the state-wide total of recreational fishing trips, estimated by the MRFSS telephone survey of households. Catch in weight was estimated from catch in numbers and an annual state-wide mean weight measured in the creel survey.

The restricted MRFSS data set generated annual estimates of total catch that were within a few percent of the MRFSS standard estimate, which is based on the total data set. However, the Review Panel seriously questioned the way in which MRFSS data were used to generate a catch-effort index of

[2] i.e. 'trips that did not capture hogfish, but targeted or captured principal species in the snapper-grouper complex of reef fishes'.

abundance. The fundamental problem is that hogfish are very difficult to catch by angling, and few anglers target, or intend to catch, them. Therefore, even the restricted angling data set contained millions of angling trips, most having no interest in hogfish, with very low average catch rates. It was doubted that this constituted a consistent effort base against which the catch could validly be scaled to provide an index of abundance. Another, perhaps less important problem, was a possible change in catch-effort ratios after size limits were introduced in 1994; it was, however, suggested that this problem might be resolved by adding 'B2' catches (i.e. fish released alive) in MRFSS records to the data included in the analyses.

The Review Panel eventually concluded that angling trips should not be used to generate an index of abundance for the assessment, and that the treatment of the MRFSS data should be restricted to spear-fishing trips, less numerous but considered more likely to have catch: effort ratios genuinely related to hogfish density.

Of commercial trips in the trip-ticket dataset, valid trips comprised i) trips that caught hogfish and ii) 'reef fish trips' that used gears that caught hogfish and also were from counties with at least 3 trips that caught hogfish. Effort was imprecisely recorded for commercial trips and for most gear types the trip was the effort measure retained. It was observed that the imposition of length limits in 1994 was likely to have biased data after that year with respect to earlier data. The Review Panel decided that commercial effort series from 1994 onwards were adequate and appropriate. However, it concluded that commercial effort data from before that were not comparable owing to lack of information on gear type, as well as the length limit intervention.

Two other fishery-based data series were used, but only to generate information on lengths of landed fish. One was a survey on head-boats in the Keys, the other a creel survey of recreational fishermen using boat ramps in Biscayne National Park. Although only limited information was presented on these series, the Review Panel considered that, with appropriate reservations on geographical scope of these separate data sets, they gave information on the distribution of lengths that was usable in the assessment.

Fishery-independent abundance data comprised one visual census series (RVC), carried out by divers using standardized methods in the Florida Keys reef tract from 1979 to 2002, which included data on both density and length composition.

After considerable discussion on the methods used for counting and recording the numbers of the many different species of fish that might possibly be encountered, mitigating the possible disturbance due to the observing divers, and estimating or measuring length, the Review Panel considered that the RVC data were acceptable for the assessment, with appropriate reservations due to its area and depth restrictions.

An extension of the RVC survey to the Dry Tortugas in 1999 and 2000 was used in the assessment only as a source of data on length distribution, and the Review Panel considered it acceptable for use in the assessment with appropriate caveats due to its restricted geographical coverage.

Basic biological data that were available included: age-length data, from which von Bertalanffy growth curves were derived; a length-weight function; a maturity function; a fecundity-weight relation; age-specific rate of sex change; and additional data on biological parameters such as longevity, maximum length and maximum weight recorded.

The Review Panel discussed the problem of the age-length data. The assessment presented separate growth curves for the eastern Gulf of Mexico and the Florida Keys reef tract[3]. The Keys data lacked fish over 13 years in age and the fitted curve had a low asymptote. The assessment document concluded, without presenting significance statistics, that the Keys data set was a biased representation of the age-length relationship because of the removal of large fish by intense fishing, and that as the Gulf of Mexico data had less bias it would be more appropriate to use it on its own to convert lengths to ages than to combine the two data sets, even in the case of the RVC length data from the Keys reef tract. This decision was supported by the observation that the Gulf of Mexico data agreed closely with an available age-length dataset and fitted growth curve from Cuba[4] .

The Review Panel had misgivings about rejecting an age-length relationship fitted to data from the reef tract, but it was pointed out that the reef-tract curve was incapable of converting to ages the full range of lengths encountered in the RVC survey, while the Gulf of Mexico curve could. Therefore, given the

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[3] McBride, R. 2001. Age, growth and reproduction of hogfish, *Lachnolaimus maximus*. FMRI Final Report FO723-98-00-F.

[4] Claro, R., K.C. Lindemann and L.R. Parenti. 2001. Ecology of the Marine Fishes of Cuba. Smithsonian Institution Press, Washington D.C. 253 pp.

confirmation of the Cuban dataset, the Review Panel considered that the selection and use of this data were acceptable. However, the Panel also suggested testing the effects of using a growth curve based on the two Florida data sets combined.

Length-weight and weight-fecundity relationships were also included in the assessment modelling calculations.

Evaluate the adequacy, appropriateness, application and results of models used to assess stocks (e.g., measures of exploitation, abundance, and biomass).

There was no definition of the stock, and the Review Panel considered that the stock to be considered would be Hogfish in waters off Florida.

In order to use catch/effort ratios from several different 'fleets' (types of fishing activity) in combination as time-series of abundance indices, effort was standardized using an analysis of variance to estimate gear calibration factors. Seven commercial gear types and two recreational gear types were considered, with year, season and county as independent factors.

The Review Panel considered that the standardization method used was appropriate.

Total mortality in the recruited stock was directly estimated from mean length of recruited fish and the parameters of a von Bertalanffy growth curve. Length data were obtained from fishery data and from visual diver surveys. Natural mortality, estimated by regarding observed longevity either as the 5% or the 1% lifetime survival point, was deducted to estimate fishing mortality. An alternative estimate of natural mortality was obtained from the length structure of pre-recruits from the RVC data.

The Review Panel observed that use of L_{bar} to estimate mortality[5] requires an assumption of stationarity in population characteristics and the fishery system, and further observed that it was not clear that such assumptions were adequately met. Survey indices show recruitment increasing since 1987,

[5] Ault, J.S., and N.M. Erhardt. 1991. Correction to the Beverton and Holt Z-estimator for truncated catch length-frequency distributions. ICLARM Fishbyte 9: 37–39.

which would imply that such estimates of total mortality would have positive bias[6]. Size limits were imposed in 1994, which also might affect L_{bar} estimates of Z. L_{bar} estimates are also sensitive to growth-curve parameter values. Smoothing the average size in an appropriate way might mitigate these problems.

Both a spreadsheet adaptation of an age-structured stock-synthesis model, and a block-biomass (surplus production: ASPIC[7]) model were applied to the assessment. The design of these models was not clearly understood from the assessment document and the Review Panel requested a number of clarifications (see Appendix I) that it expected would contribute to its ability to judge the adequacy and appropriateness of these models.

Because of a number of limitations in the documentation both of the models used, and of their relation to the results presented, the Review Panel found it difficult to assess the adequacy and appropriateness of the models and of their results. During its review the Panel identified possible problems with the data series used in the assessment, including some that might induce bias in estimates of stock-status parameters.

Therefore, the Review Panel was unable to make quantitative statements about the parameters needed to determine current stock status. However, it did identify some particular features in the data from which qualitative conclusions might be drawn, including: i) recent increased numbers of pre-recruits and recruited fish in the RVC series indicate a recent increase in recruitment; and ii) the distribution of size in the Florida Keys is truncated, possibly indicating high fishing mortality. Furthermore, F estimated by L_{bar} from various data sources, while in some cases likely to be positively biased, consistently exceeded natural mortality, as well as F_{max} and other standard benchmarks for F.

Evaluate the adequacy, appropriateness, application, and results of models used to estimate population benchmarks and Sustainable Fisheries Act status determination criteria (e.g., MSY, F_{msy}, B_{msy}, MFMT, MSST, and OY).

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[6] Quinn, T.J., II, and R.B. Deriso. 1999. Quantitative fish dynamics. Oxford University Press, New York. 542 pp.

[7] Prager, M.H. 1994. A suite of extensions to a non-equilibrium surplus-production model. Fishery Bulletin 92: 374–389.

The only model used to estimate population benchmarks was a yield-per-recruit analysis, considered 'pretty straightforward'. Estimates resulting were $F_{0.1}$ = 0.10/yr and F_{max} = 0.16/yr, both conditional on a recruitment length of 12 inches.

Evaluate the adequacy, appropriateness, and application of models used for rebuilding analyses where appropriate, and estimate, to the extent possible, generation time and rebuilding time in the absence of fishing mortality.

The model used to estimate rebuilding time was a stock simulation model developed at the University of Miami (Rosenstiel School of Marine and Atmospheric Science). However, the Panel was unable to find adequate evidence that the stock is overfished and concluded that rebuilding times could therefore not appropriately be considered at this time.

Develop recommendations for improving data collection and assessment and future research (both field and assessment).

The Review Panel recommends the following improvements in data collection:

Reef-fish commercial log-books should be considered as an additional source of data on commercial catch and effort.

Weight data, as well as length, should be collected in the head-boat survey;

Using data from spearfishing tournaments could reinforce length-weight relationships, especially at the right-hand end of the distribution where data are rare.

The Review Panel considers it important to maintain the current data-collection programs.

The Review Panel observed that both it, and the presenters, had been handicapped in this review in that neither a data workshop, which would have verified the data sources, nor an assessment workshop had previously been held.

Comments of the Review Panel on the assessment and its documentation.

The Review Panel found itself handicapped in reviewing the assessment by lack of clarity in the documentation of some aspects of the assessment model, the underlying data, and their treatment. The Review Panel therefore thought it appropriate to make the following recommendations relating to the assessment model and its documentation:

- Section 2.2 Fishing Trips and Landings; 2.2.1. Recreational Fleet (pg. 9): Give frequency distributions of fishing times for each gear-mode combination. These distributions are noted as being highly skewed, with the median value used for missing values of trip fishing times.
- Document cohort slicing methods in the assessment report.
- Document the use of size data from the Biscayne National Park creel surveys, from the recent dive surveys in the Dry Tortugas, and from the head-boat port sampling; summarize the data.
- Document size frequencies for south, east, and west Florida, and evaluate potential differences between the size distributions.
- Document likelihood profiles of model output estimates.
- Document in text, tables, and/or figures whether the MRFSS data set included only Type A or Type A and Type B1 data.
- Provide information on (tabulate) management regulations and interventions with month and year of implementation.
- Document Sums of Squares (Type I/III) plus coefficients, etc., in Table 2.4 for the GLM analysis.
- Consider comparing the L_{bar} estimator before and after the intervention.
- Estimate spawning stock biomass both for females alone, without the male component, and as total mature biomass.
- Provide a listing of the inputs, the assumptions, and the specifications of parameter values for each class of basic model.
- Document the stock-recruit relationship used (Beverton-Holt), with the choice of steepness value and the rationale for it.
- Clarify in the documentation the final form of each basic model, and ensure that the defining equations properly correspond.

ADDITIONAL COMMENTS

There were none.

III STAKEHOLDER COMMENTS

Jim Gillespie, of Melbourne Beach, Fla, presented an informal survey of headboat captains from the Florida east coast, in which they reported that headboats targeting snapper/grouper, and in some cases other reef fish, very seldom catch Hogfish (estimated 1 hogfish for 18,500 line-days).

Ed Walker, a charter Captain from New Port Richey, FL presented Internet poll data on angling catches of Hogfish and concluded that they are very rare. The poll was conducted on the Florida Sportsman Fishing Forum, an Internet website built and maintained by Florida Sportsman magazine, a Primedia publication, for the use of the public to engage in the exchange of fishing information. The poll was responded to over 400 times and concluded that hogfish caught on hook and line are very rare. Comments added to the poll indicate that hook-and-line *efforts* for hogfish are almost unheard-of.

From Dennis O'Hern, Secretary of the St Petersburg Underwater Club (SPUC): 'SPUC is a 60 member spearfishing club whose members are among the elite of the sport. SPUC has organized the St. Pete Open spearfishing tournament for 37 consecutive years. The St. Pete Open is the largest, oldest spearfishing tournament in the United States, held each August in St. Pete, FL, attracting over 300 participants last year. Hogfish is one of the targeted species for the tournament. The results for the hogfish category of the tournament are submitted for 1983-1992 and 1997-2003 and show an increase in average weight. All weights shown are gutted weights. Data from 1993-1996 were unavailable at the time of publication. The tournament results indicate a healthy population of hogfish.

'The members of the club do not, nor have they ever, targeted hogfish with hook-and-line gear. It is the St. Petersburg Underwater Club's belief that recreational and commercial hook and line trips do not target hogfish and are therefore invalid in their use as data to assess the hogfish stock. Incidental, random by-catch of a species is not indicative of the state of health of the hogfish stock.'

Table: Number, mean weights and greatest lengths of hogfish entries at the St Pete Open Spearfishing tournament, Aug. 1983–2003. (submitted by Dennis O'Hern, Sec'y, St Petersburg Underwater Club)

Year	Entries	Hogfish	Average Wt	Lrg 1	Lrg 2	Lrg 3	Lrg 4	Lrg 5
2003	318	118	5.59	17.5	16.6	16.6	16.2	15.8
2002	234	88	4.87	19.3	17.8	17.6	16.3	16
2001	209	124	7.24	21.2	20.6	20.2	19.9	19.9
2000	212	108	4.87	20.2	18.7	15.7	13.8	13.4
1999	201	103	5.16	18.9	17.8	17.4	17.4	17.1
1998	191	102	3	16.8	15	12	8	7.6
1997	198	78	5.48	19.5	19.2	19.1	17.4	16.4
1996								
1995								
1994								
1993								
1992	217	46	3.1	7.6				
1991	228	38	4.1	15				
1990	237	67	5.7	20.3				
1989	257	88	4.2	18.7				
1988	289	88	2.8	7.4				
1987	222	56	2.3	10.1				
1986	201	37	2.4	4.1				
1985	160	28	3	5.1				
1984	136	27	2.2	5.1				
1983	160	42	2.5	8				

IV RECOMMENDATIONS FOR THE CONDUCT OF FUTURE WORKSHOPS

The review would have been more reasonable if the data had been vetted by a data workshop and if the assessment had been examined by an assessment workshop. The assessment would have been easier to review if the document had been reviewed and edited.

ANNEX I: ADVISORY REPORT

Advisory Report

Hogfish

Stock Identification and Distribution: In Florida, Hogfish are primarily found in the warm subtropical and tropical waters of the coral reef ecosystem, and are primarily associated with shallow, low-relief, hard-bottom and patch-reef environments. Larger mature fish are normally found on the reefs, although Hogfish are often encountered in gorgonian-covered low-relief habitat. Ontogenetic migrations occur between the shallow coastal lagoons that serve as nursery areas for juveniles and the offshore coral-reef and hard-bottom habitats used by adults. This assessment applies only to Hogfish in the area covered by the available survey data, i.e. waters off Florida. Status of Hogfish outside this area was not evaluated.

State of Stock: Qualitative evidence suggests that Hogfish in waters off Florida may be experiencing growth overfishing. It is not known whether the stock is overfished or whether overfishing relative to SFA criteria is also occurring.

Management Advice: Yield might be increased by increasing the size limit.

Forecasts: No forecasts were made.

Catches: Annual Hogfish catches in Florida by fleet (commercial and recreational) were estimated for 1982–2001 (Figure 1). Over the past 15 years, recreational catches have declined from a peak of 238 mt in 1987 to an average of 187 mt/yr in 1992–1993; catches from 1998–2001 were approximately 60 mt/yr, even though the number of fishing trips remained fairly constant during 1991–2001. Commercial landing estimates were lower than recreational catches. Estimates of annual catch peaked in 1989–1994 (range: 42–62 mt), and declined from 1995 to present (range: 20–29 mt).

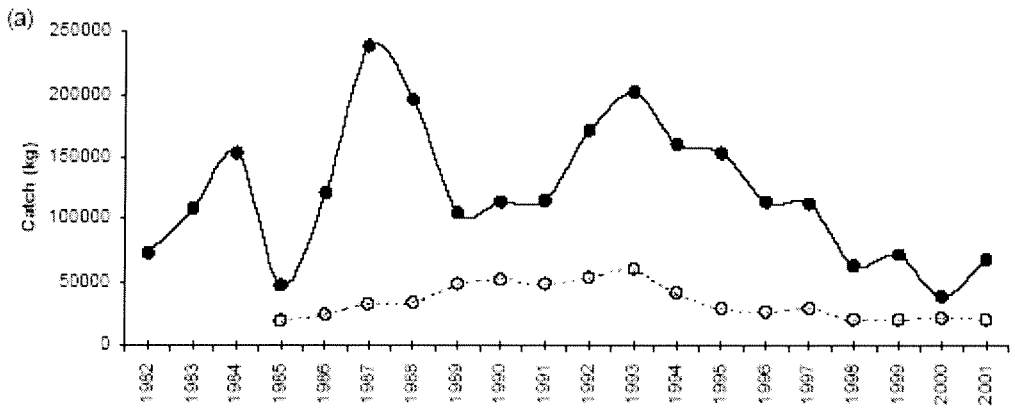

Figure 1. Commercial (○) and recreational (●) hogfish catches in Florida 1982–2001.

Data and Assessment: Catch and effort data are available from the MRFSS and the Florida Trip Ticket Program. Fishery-independent data are available from the RVC survey. The Review Panel did not accept the assessment results as presented, owing to concerns about selection of tuning indices, a lack of

detail regarding particular model configurations, and concerns that assumptions for some models proposed were violated. Relative trends in population characteristics such as recruitment (juvenile density) and biomass can be evaluated from the fishery-independent survey data (Fig. 2).

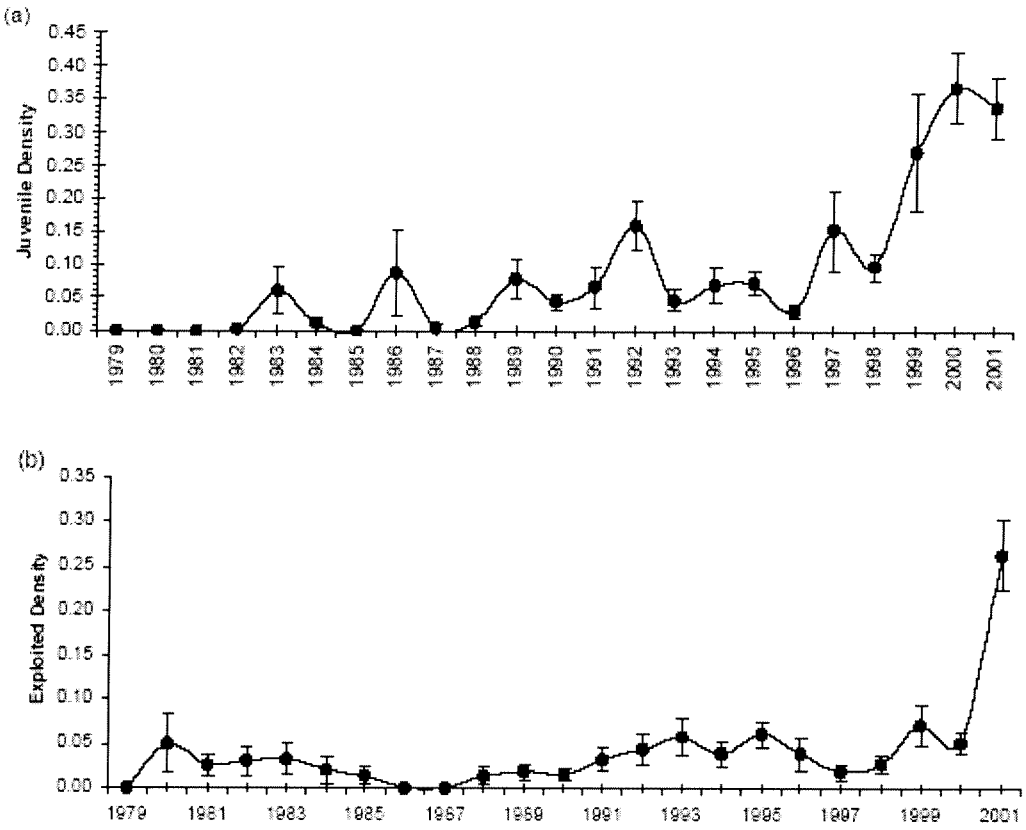

Figure 2. Hogfish density indices from RVC diver visual surveys 1979–2001.

Biological Reference Points: Biological reference points were estimated based on yield-per-recruit modeling: $F_{0.1}$=0.10/yr and F_{max}=0.16/yr, based on a 12-inch size limit.

Fishing Mortality: No reliable estimates of fishing mortality are available, and current estimates of fishing mortality are acceptable only as qualitative indicators. Although estimates from L_{bar} were expected to be positively biased, such estimates were roughly twice as large as natural mortality as well as F_{max} and other standard benchmarks. This provided a qualitative indication that overfishing of Florida Hogfish may be occurring. However, in the absence of a quantitative estimate of the bias, it was not possible to conclude that overfishing is occurring.

Recruitment: Recruitment trends can be qualitatively evaluated through RVC survey data. Annual mean densities from the survey for juvenile Hogfish (length < 199 mm) were fairly stable from 1989 to

1996, with the notable exception of a density increase in 1992 (Figure 2). From 1996-2000, juvenile density appears to have undergone a substantial increase, leveling off in 2001.

Stock Biomass: Estimates of stock biomass were not considered acceptable; however, trends in biomass over a limited area can be evaluated from the RVC survey data. Densities of Hogfish from this survey generally increased from 1987 to the present. Recent estimates are among the highest in the series.

Special Comments: The basic structure of the modeling exercise appears adequate; however, several model parameters were unavailable and this precluded proper screening of input variables. Moreover, the design of certain models was not adequately documented. As a result, the Review Panel indicated there was not a solid basis for accepting the quantitative assessment of the current status of the stock or the conclusions stated in the assessment. Also, assuming model issues are resolved, there is still a clear limitation regarding the applicability of the model to other areas of the Gulf and eastern coast of U.S.

Angling trips should not be used to generate an index of abundance for assessments of this species: the treatment of the MRFSS data should be restricted to spear-fishing trips, less numerous but more likely to have catch: effort ratios related to Hogfish density. Imposition of length limits and permit restrictions in 1994 and earlier was likely to have altered fishery-dependent data with respect to earlier data. The Review Panel decided that the commercial effort series from 1994 onwards was adequate and appropriate for use in an assessment.

Sources of Information:

Ault, J.S., S.G. Smith, G.A. Diaz, and E. Franklin. Florida hogfish fishery stock assessment, SEDAR6-RW-4, 89 pp.

Anonymous. SEDAR Hogfish Assessment, SEDAR6-RW-5, 3 pp.

ANNEX II: GLOSSARY AND ABBREVIATIONS

B	stock biomass level
B_{msy}	value of B capable of producing MSY on a continuing basis
CPUE	catch per unit of effort
GMFMC	Gulf of Mexico Fishery Management Council
F	(instantaneous) fishing mortality
F_{msy}	fishing mortality to produce MSY under equilibrium conditions
$F_{50\% SPR}$	fishing mortality that will result in $B_{50\% SPR}$ under equilibrium conditions
F_{max}	fishing mortality that maximises the average weight yield per fish recruited to the fishery
$F_{0.1}$	a fishing mortality close to, but slightly less than, F_{max}
FMRI	(State of) Florida Marine Research Institute
GLM	general linear model
L_{bar}	mean length
M	(instantaneous) natural mortality
MFMT	maximum fishing mortality threshold, a value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey; combines a telephone survey of households to estimate number of trips with creel surveys to estimate catch and effort per trip
MSST	minimum stock size threshold, a value of B below which the stock is deemed to be overfished
MSY	maximum sustainable yield (equals F_{msy} times B_{msy})
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
OY	optimum yield
RVC	Reef Visual Census—a diver-operated survey of reef-fish numbers
SAFMC	South Atlantic Fishery Management Council
SEDAR	Southeast Data, Assessment and Review
SFA	Sustainable Fisheries Act of 1996
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock
Z	total mortality, the sum of M and F